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**(54) Reformer furnace with internal recirculation**

(57) A reformer furnace (1) having a cylindrical shell (10) with an open outlet (20) end in bottom of the shell (10), and a burner (4) surrounded by a wall (6) spaced apart the burner (4) arranged within the shell (10) and spaced apart from inner wall surface of the shell (10), thereby defining a reformer chamber between the burner wall (6) and inner surface of the shell (10) and a combustion chamber (14) within the wall (6) surrounding the burner (4). One or more reformer tubes (8), having an outer tube with a closed end and an open ended inner tube are arranged vertically within the reformer chamber, so that a hot flue gas from the burner (4) circulates with an upward flow in the combustion chamber (14) and a downward flow in the reformer chamber.

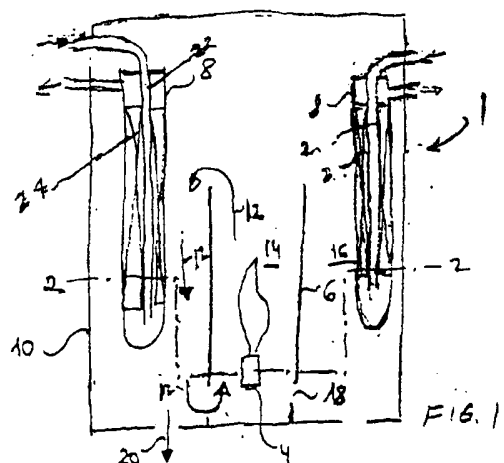


FIG. 1

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## Description

[0001] This application claims the benefit of U.S. Provisional Application Serial No 60/062,888, filed on 23 October 1997 and U.S. Provisional Application Serial No 60/064,191 filed on 4 November 1997.

## BACKGROUND OF THE INVENTION

[0002] Steam reforming is a chemical process by which hydrocarbon and steam react to form hydrogen, carbon monoxide and carbon dioxide. The reaction is strongly endothermic.

[0003] The reactor in which this process takes place is a reformer.

[0004] One type of reformer consists of a furnace, equipped with a number of tubes filled with an appropriate reforming catalyst. Hydrocarbon and steam flow through the reformer tubes. Burners in the furnace supply the heat, which is transferred to the reformer tubes in which the endothermic reforming reaction takes place.

[0005] The burners of a reformer furnace may be arranged in different ways. One of the best ways is to place a large number of burners on the furnace walls in such a way that the walls are heated and reflect this heat by radiation to the reformer tubes. The general object of this invention is to provide a reformer furnace that releases heat to the tubes from a large surface of uniform high temperature rather than from the small and very hot volume of a flame.

## SUMMARY OF THE INVENTION

[0006] This invention provides a reformer furnace having a cylindrical outer shell with an open outlet at the bottom; a burner concentrically surrounded by a wall spaced apart from the cylindrical outer shell, thereby defining an annular reformer chamber between the burner wall and the inner surface of the outer shell and a combustion chamber within the wall surrounding the burner. One or more reformer tubes, having an outer tube with a closed end and an open ended inner tube are arranged vertically within the reformer chamber, so that hot flue gas from the burner circulates with an upward flow in the combustion chamber and a downward flow in the reformer chamber.

## BRIEF DESCRIPTION OF THE DRAWING

[0007]

Figures 1 and 2 of the appended drawing diagrammatically illustrate the reformer furnace of this invention in vertical section and horizontal section, respectively.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

[0008] Referring to the drawing, the furnace 1 has one large burner 4, placed at the furnace bottom. The burner is surrounded by a wall 6, which is open at the top and has openings at the bottom. The reformer tubes 8 are placed outside this burner wall and inside the furnace outer wall 10. When the burner is in function, the flue gas from the flame will circulate around the burner wall 6 as shown by the arrows 12 in the Figure. The flue gas will have an upwards flow in the combustion chamber 14 and a downwards flow when it is cooled in the reformer tube chamber 16. When the flue gas at the furnace bottom flows through the burner wall openings 18, a part of it will leave the furnace as shown by arrows 20, while the main part will mix into the upwards flow in the combustion chamber.

[0009] By control of the circulation rate, the temperature of the burner wall is adjusted to a level where uniform radiation to the reformer tubes in combination with the convection from the downwards flow will supply the necessary heat for the reforming process.

[0010] Each reformer tube 8 has an open ended central passageway 20 surrounded by a catalyst bed 22. Feed to be reformed is fed downwardly to the central passageway and passes upwardly through the catalyst bed, and the product leaves from the top of the catalyst bed.

[0011] A preferred layout provides one burner surrounded by the burner wall, which is surrounded by a circular row of reformer tubes, which again is surrounded by an outer circular furnace wall.

[0012] Another preferred layout is in the form of a multi-burner furnace with a number of burners, each surrounded by a burner wall in a matrix of reformer tubes, placed in a square or rectangular furnace.

[0013] Although the present invention has been described in relation to particular embodiments thereof, many other variations and modifications and other uses will become apparent to those skilled in the art. Therefore, the present invention is to be limited not by the specific disclosure herein, but only by the appended claims.

## Claims

1. A reformer furnace comprising an outer shell with an opening in its bottom, at least one burner surrounded by a wall spaced apart from the burner, said wall being arranged within the shell and spaced apart from inner wall surface of the shell, thereby defining a reformer chamber between the burner wall and inner surface of the shell and a combustion chamber within the wall surrounding the burner; and

one or more reformer tubes, each tube comprising an outer tube with a closed outlet end and an open ended inner tube, the reformer

tubes being arranged vertically within the reformer chamber, so that a hot flue gas from the burner circulates with an upward flow in the combustion chamber and downward flow in the reformer chamber.

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2. A reformer furnace as in claim 1, wherein said outer shell is cylindrical, there is a single burner surrounded by a wall concentrically arranged within the shell, and the reformer chamber is annular.

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3. A reformer furnace as in claim 1, wherein a plurality of burners are provided within the outer shell.

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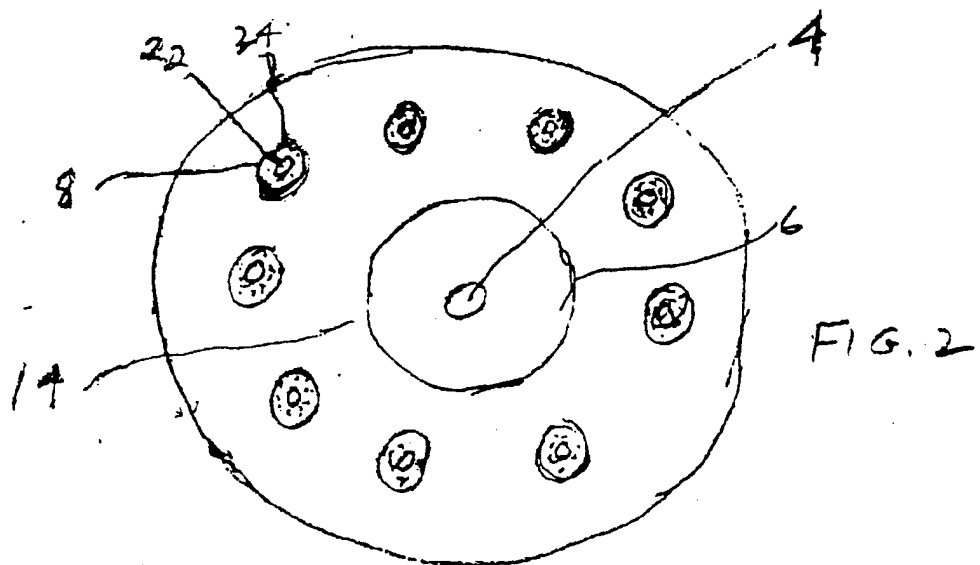
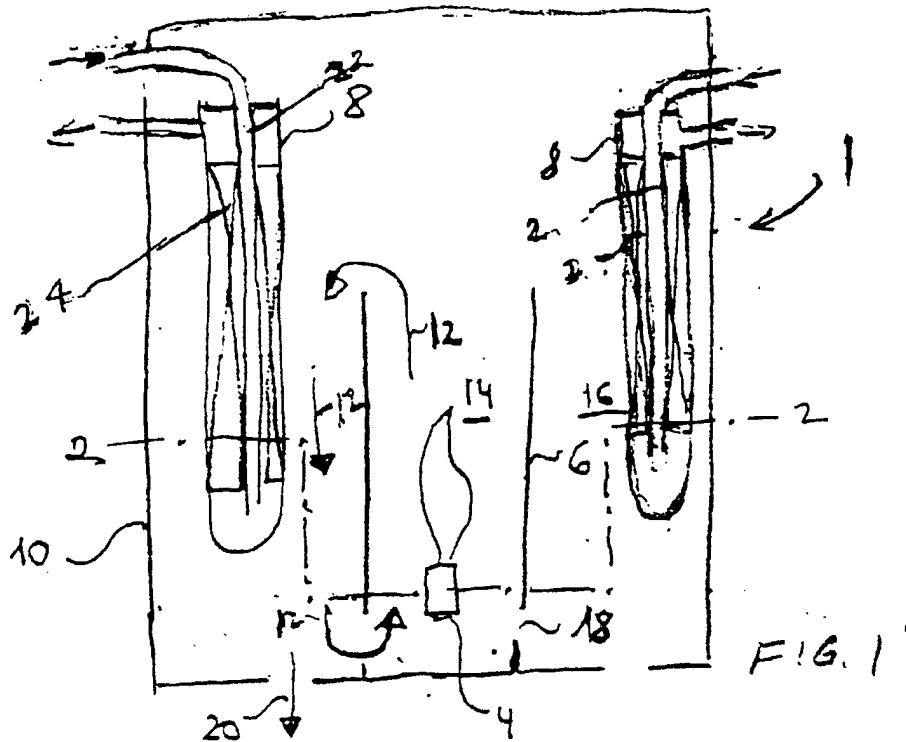
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## EUROPEAN SEARCH REPORT

Application Number  
EP 98 11 9394

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	GB 895 038 A (THE GAS COUNCIL) * page 1, left-hand column, line 9 - line 23 * * page 2, right-hand column, line 72 - page 3, left-hand column, line 13 * * page 3, right-hand column, line 111 - page 4, left-hand column, line 36 * * figures 2,4 *	1,2	B01J8/06
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			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B01J
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		22 February 1999	Stevnsborg, N
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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